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Propagation "over the horizon" of Saturn's radio lightning studied by three-dimensional ray tracing

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Saturn Electrostatic Discharges (SED) are radio signature of lightning flashes originating from Saturn atmosphere. Before the equinox in 2009, observations by Cassini/ RPWS (Radio and Plasma Waves Science) and Cassini/ ISS (Imaging Science Subsystem) have shown strong correlation between the periodicity and occurrence of radio bursts and cloud features localised at a planetocentric latitude of 35° South. When Cassini was located in the morning sector, the cloud system appeared on the nightside and disappeared on the dayside, but the detection of SED started before the cloud system was seen with the Cassini camera. This effect is called the "over the horizon" effect, as the radio horizon extends as much as 45° beyond the visible horizon. Moreover, both the apparition and disappearance of bursts appear to be frequency-dependent: lower frequencies start and stop earlier than higher ones. On the dayside, a simple explanation relies upon the dependence of the low-frequency cutoff on the angle of incidence of radio waves on Saturn's ionosphere. On the nightside, the "over the horizon" effect is more puzzling and has been qualitatively attributed to propagation effects through the nightside ionosphere, where electron density varies with the local time.
We built a 3D ray tracing code, which computes the path propagation of radio waves through a realistic model of Saturn's ionosphere, where electron density varies with the local time, and were able to reproduce the typical dynamic spectrum of observed "over the horizon" events. Extension of this study to a quantitative fit of the low-frequency cutoff of many SED episodes will allow us to put constraints on Saturn's ionosphere models as well as on the altitude of the SED-generating clouds.